



Appendix D.4

Utility B Field Site Simulation Summary



Secondary Distribution Effects of EV Chargers Utility B

Field Site Simulation

The results of the simulations for the field site are presented below. A particular day on which three chargers turned on at midnight was chosen and the loading for the various consumers was constructed from field site data for that day.

Field Case Scenario

The Honda EVPLUS and Nissan Altra EVs were used in the field site. The EV charger models were EVI ICS-200 for the EVPLUSs and Magnecharge for the Altras. The current waveforms and their harmonic spectrum are shown in Figs. 1 and 2. The field site configuration is shown in Fig. 3. The source voltage was assumed to have a background voltage distortion of 3.4%, which was the typical voltage THD for the system obtained from the field data. The simulation parameters are shown in Tables A and B. The results obtained are shown in Fig. 3 and Table C. The system performance with regard to line and transformer losses is shown in Table D.

It was seen in the field site results that there was an extraneous load of 5 kW, which was switched on at the same time when the chargers came on. This load did not occur in any of the four houses with the EVs as can be seen from the RPM data. To account for this in the simulation, the extra loads coming on at midnight have been assumed as a dishwasher (in house #3) and other home-office loads (in houses #1 and #3). In all tables and figures, the two phases of the split phase secondary of the distribution transformer have been referred to as lines X1 and X3.

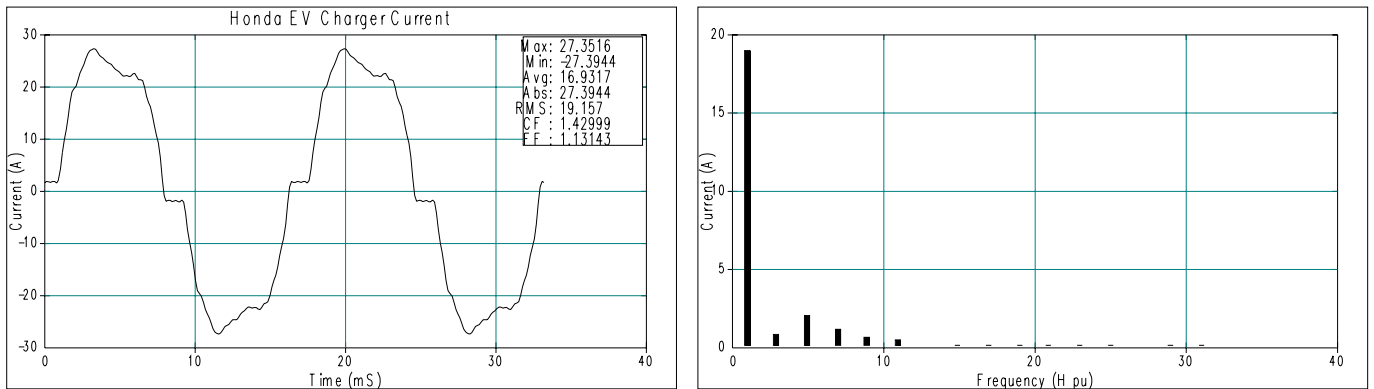


Fig 1. Honda EV Charger Current Waveform and Spectrum

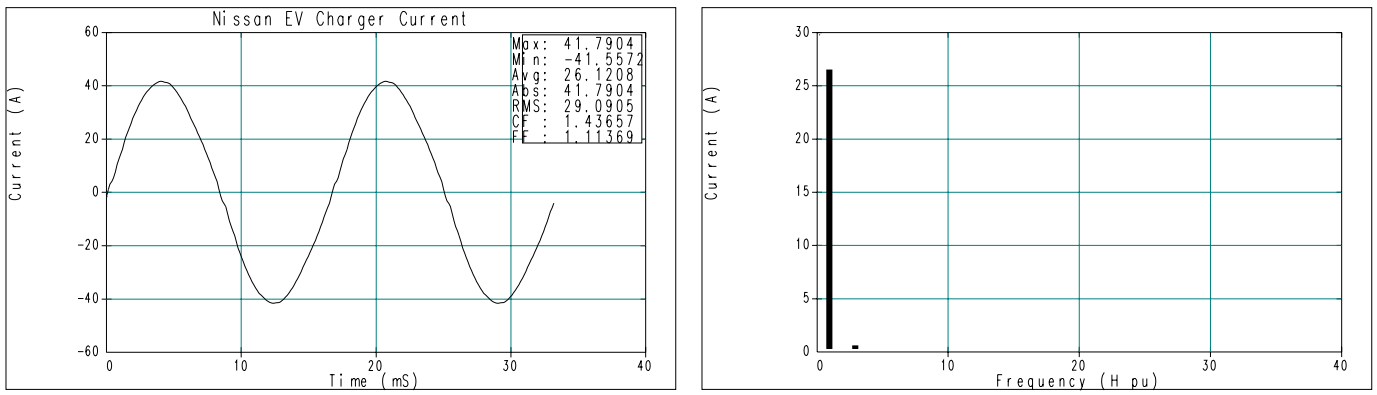


Fig 2. Nissan EV Charger Current Waveform and Spectrum

Table A. Simulation Parameters

Parameter	Value
EV Charger Penetration %	50
Distribution Service Transformer	50 kVA %Z=2.2 %R=1.5, %X=1.7
Secondary Conductor Used	350 Al
Service Conductor Used	4/0 Al
No. of customers	6
Total Load before Charging	6.0 kW
Total Load during Charging	29.8 kW
% Loading during Charging	59.6 %

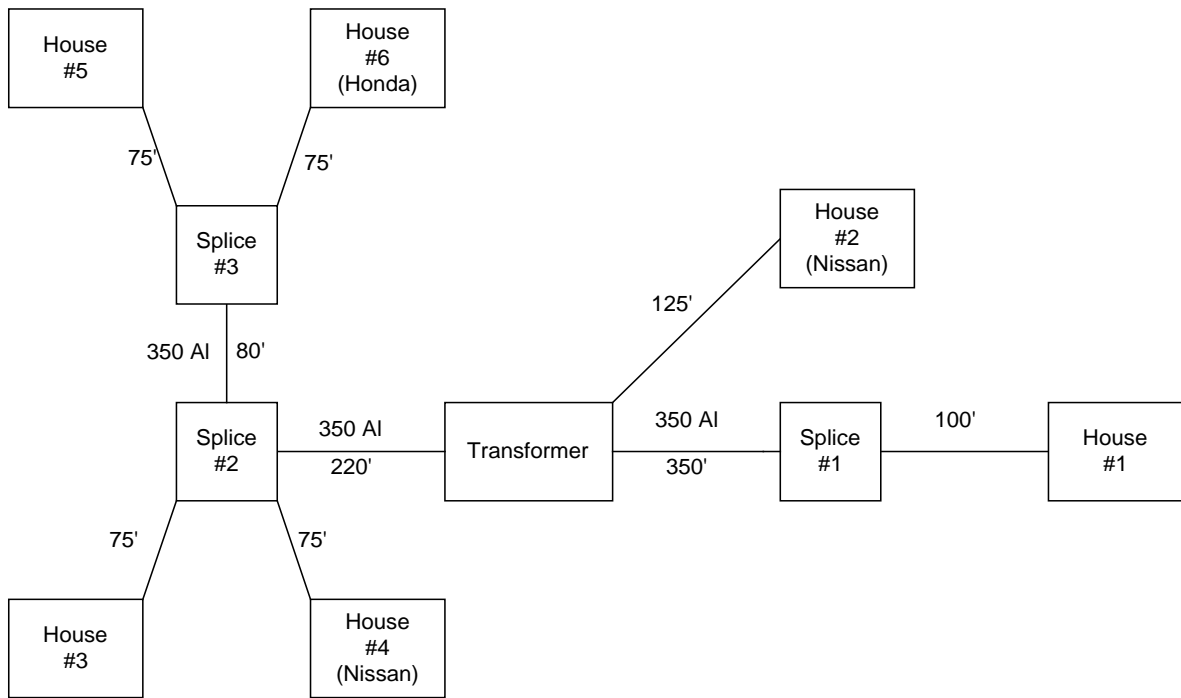


Fig. 3. Field Site Configuration for Worst Case Simulation

Table B. Appliances used in simulation

Appliance	Load (kW)	Appliance	Load (kW)
House #1		House #2	
Refrigerator	0.7	Refrigerator	1.0
Lights	0.3	Lights	0.4
Computer	0.6	Nissan EV Charger	7.1
Total Load	1.6	Total Load	8.5
House #3		House #4	
Computer	0.4	Refrigerator	0.8
Printer	1.0	Fan	0.3
Dishwasher	2.5	Nissan EV Charger	7.1
Total Load	3.9	Total Load	8.2
House #5		House #6	
Refrigerator	0.5	Lights	0.6
Office Jet/FAX	1.4	Honda EV Charger	5.1
Total load	1.9	Total Load	5.7

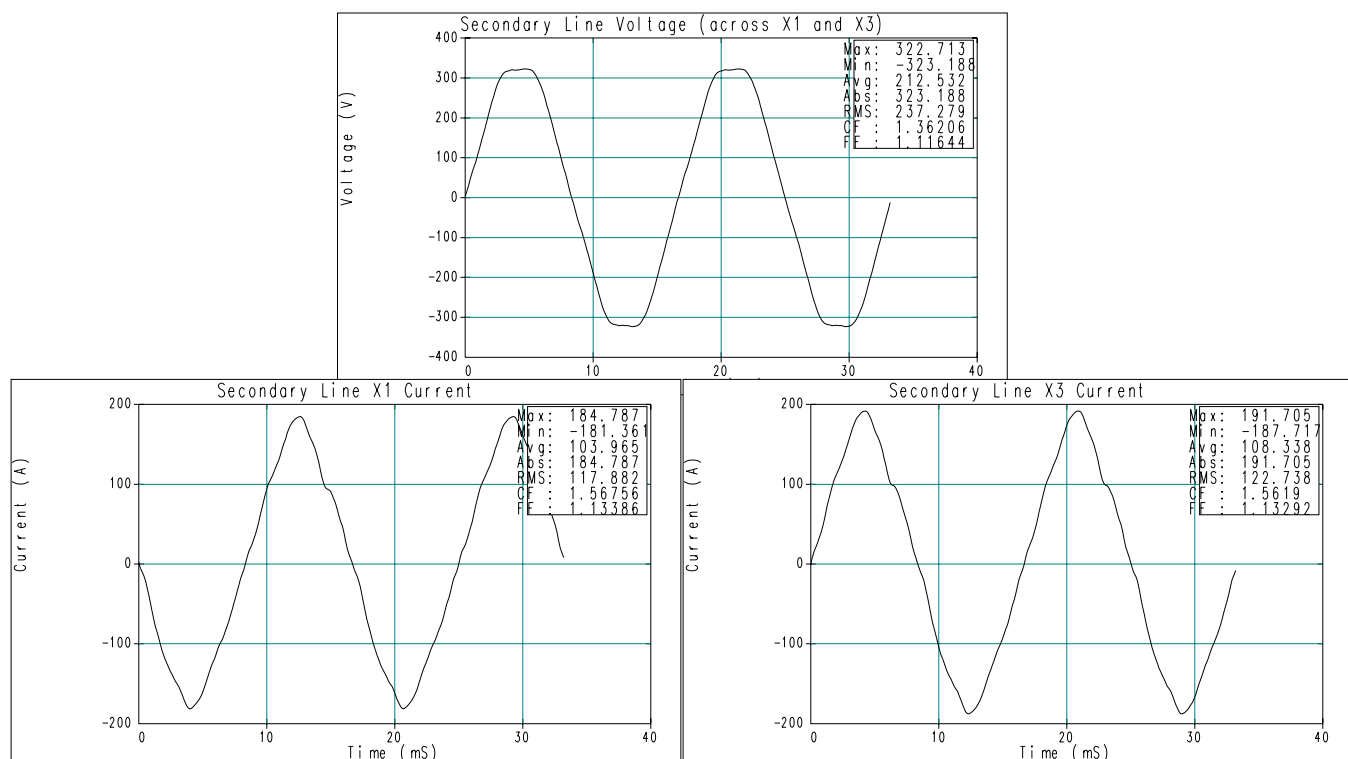


Fig 3. Field Site simulation results

Table C. Field Site Simulation Results

	X1 Line Curr.			X3 Line Curr.			Sec. Line Volt.(V)	Sec. Line Voltage THD (%)
	Sim (A)	THD (%)	Distortion Current (A)	Sim. (A)	THD (%)	Distortion Current (A)		
Before Charging	26.2	21.1	5.3	30.8	17.8	5.4	239.5	3.5
During Charging	117.9	7.6	8.8	122.7	7.3	9.0	237.3	3.6

Table D. Line and Transformer Losses

	Line Losses (W)	Transformer Winding Losses (W)	K Factor	Transformer Derating
Before Charging	8.3	16.6	1.5	0.98
During Charging	140.4	252.1	1.1	1.0

Comparative Study

A comparison of the field simulation results and the actual field data was performed. The comparison of the results is shown in Table E. The field data and the simulation results for the voltage THD match within 2.9%, thus validating the simulation process.

Table E. Comparison of simulation results and field data

	Before Charging			During Charging		
	Simulation	Field Data	% Diff.	Simulation	Field Data	% Diff.
X1 Line Current	26.2 A	24.4 A	7.4	117.9 A	123.8A	-4.8
	21.1% THD	23.4% THD	-9.8	7.6% THD	7.2% THD	5.6
X3 Line Current	30.8 A	31.3 A	-1.6	122.7 A	127.3 A	-3.6
	30.8% THD	24.1% THD	27.8	7.3% THD	7.1 % THD	2.8
Secondary Voltage	119.8 V	123.8 V	-3.2	118.9 V	123.1 V	-3.4
	3.5% THD	3.4% THD	2.9	3.6% THD	3.5% THD	2.9
Line Losses	8.3 W	10.1 W	-17.8	16.6 W	18.2 W	-8.8
Transformer Losses	140.4 W	146.2 W	-4.0	252.1 W	288.2 W	-12.5
K Factor	1.5	1.6	-6.3	1.1	1.1	0.0
Transformer De-rating	0.98	0.98	0.0	1.0	1.0	0.0